SYSTEM/USER PROMPT MESSAGE	DESCRIPTION
FACTORY DEFAULTS SET	This message appears in the Restore Defaults Menu and informs the operator that the Factory Default Settings have been restored for Air Mode, Air and Baby Set Temperature, Procedural Time, Keypad Lock Time, Audio Tone and No External Interface. Refer to Section 2, Paragraph 2.6.5, and Section 5, Paragraph 5.3.6, for an explanation and a procedure to restore the Factory Default Settings.
CONF NO EXT INTF C/F **(CONFIGURE NO EXTERNAL INTERFACE)**	This message informs the operator that the Configure No External Interface Menu has been selected from the Configuration Menu. When performed, this procedure will disable the **SERIAL PORT** located on the Controller Side Panel. Refer to Section 2, Paragraph 2.6.6, and Section 5, Paragraph 5.3.7, for an explanation and a procedure to select the Configure No External Interface Menu.
COMM SET TO NONE **(COMMUNICATIONS SET TO NONE)**	This message appears in the Configure No External Interface Menu and informs the operator that the **SERIAL PORT** located on the Controller Side Panel has been disabled. Refer to Section 2, Paragraph 2.6.6, and Section 5, Paragraph 5.3.7, for an explanation and a procedure to select the Configure No External Interface Menu.
CONF REMOTE MON C/F **(CONFIGURE REMOTE MONITOR)**	This message informs the operator that the Configuration for a Remote Monitor Menu has been selected from the Configuration Menu. When performed, this procedure will enable the **SERIAL PORT** located on the Controller Side Panel to communicate with a remote monitor. Refer to Section 2, Paragraph 2.6.7, and Section 5, Paragraph 5.3.8, for an explanation and a procedure to select the Configure a Remote Monitor Menu.
COMM SET REMOTE MON **(COMMUNICATIONS SET TO REMOTE MONITOR)**	This message appears in the Configuration for a Remote monitor Menu and informs the operator that the **SERIAL PORT** located on the Controller Side Panel has been configured to communicate with a remote monitor. Refer to Section 2, paragraph 2.6.7, and Section 5, Paragraph 5.3.8, for an explanation and a procedure to select the Configure a Remote Monitor Menu.

SYSTEM/USER PROMPT MESSAGE	DESCRIPTION
CONF THERMAL PRN C/F **(CONFIGURE THERMAL PRINTER)**	This message informs the operator that the Configuration for a Thermal Printer Menu has been selected from the Configuration Menu. When performed, this procedure will enable the **SERIAL PORT** located on the Controller Side Panel to communicate with a thermal printer. Refer to Section 2, Paragraph 2.6.8, and Section 5, Paragraph 5.3.9, for an explanation and a procedure to select the Configuration for a Thermal Printer Menu.
COMM SET TO THM PRN **(COMMUNICATIONS SET TO THERMAL PRINTER)**	This message appears in the Configuration for a Thermal Printer Menu and informs the operator that the **SERIAL PORT** located on the Controller Side Panel has been configured to communicate with a thermal printer. Refer to Section 2, Paragraph 2.6.8, and Section 5, Paragraph 5.3.9, for an explanation and a procedure to select the Configuration for a Thermal Printer Menu.
CONF DOT MAT PRN C/F **(CONFIGURE DOT MATRIX PRINTER)**	This message informs the operator that the Configuration for a Dot Matrix Printer Menu has been selected from the Configuration Menu. When performed, this procedure will enable the **SERIAL PORT** located on the Controller Side Panel to communicate with a dot matrix printer. Refer to Section 2, Paragraph 2.6.9, and Section 5, Paragraph 5.3.10, for an explanation and a procedure to select the Configuration for a Dot Matrix Printer Menu.
COMM SET TO DOT PRN **(COMMUNICATIONS SET TO DOT MATRIX PRINTER)**	This message appears in the Configuration for a Dot Matrix Printer Menu and informs the operator that the **SERIAL PORT** located on the Controller Side Panel has been configured to communicate with a dot matrix printer. Refer to Section 2, Paragraph 2.6.9, and Section 5, Paragraph 5.3.10, for an explanation and a procedure to select the Configuration for a Dot Matrix Printer Menu.
SET C500/C500 C/F	This message informs the operator that the Set C500 or C550 Menu has been selected from the Configuration Menu. When performed, this procedure will configure the Incubator to operate as either a C500 (Air Mode Only) or C550 (Air and Baby Mode). Refer to Section 2, Paragraph 2.6.10, and Section 5, Paragraph 5.3.11, for an explanation and a procedure to select the Air/Baby or Air Mode Operation.

SYSTEM/USER PROMPT MESSAGE	DESCRIPTION
CONFIG AS C550 C/F	This message appears in the Set C500/C550 Menu and informs the operator that the Incubator will be configured in both the Air and Baby Modes. Refer to Section 2, Paragraph 2.6.8, and Section 5, Paragraph 5.3.11, for an explanation and a procedure to select the Set C550 /C500 Menu.
CONFIG AS C500 C/F	This message appears in the Set C500/c550 Menu and informs the operator that the Incubator will be configured in the Air Mode only. Refer to Section 2, Paragraph 2.6.8, and Section 5, Paragraph 5.3.11, for an explanation and a procedure to select the Set C550 /C500 Menu.
C550 SELECTED	This message informs the operator that to Configure the Incubator to operate in either Air or Baby Mode has been selected. Refer to Section 2, Paragraph 2.6.9, and Section 5, Paragraph 5.3.11, for an explanation and a procedure to change the Controller configuration.
C500 SELECTED	This message informs the operator that to Configure the Incubator to operate in Air Mode only has been selected. Refer to Section 2, Paragraph 2.6.9, and Section 5, Paragraph 5.3.11, for an explanation and a procedure to change the Controller configuration.
SET LANGUAGE C/F	This message informs the operator that the Language Selection Menu has been selected from the Configuration Menu. Refer to Section 2, Paragraph 2.6.10, and Section 5, Paragraph 5.3.12, for an explanation and a procedure to select one of several languages available via the Message Center.
ENGLISH C/F **FRENCH C/F** **ITALIAN C/F** **SPANISH C/F** **GERMAN C/F** **RUSSIAN C/F**	These messages appear in the Language Selection Menu and presents the operator with the languages available when the operator presses the **Baby Set Temperature** or **Air Set Temperature** Up/Down Arrow keys. Refer to Section 2, Paragraph 2.6.11, and Section 5, Paragraph 5.3.12, for an explanation and a procedure to select one of the several languages available via the Message Center. Alternatively, Japanese may be substituted for German and Russian.

SYSTEM/USER PROMPT MESSAGE	DESCRIPTION
ENGLISH SELECTED **FRENCH SELECTED** **ITALIAN SELECTED** **SPANISH SELECTED** **GERMAN SELECTED** **RUSSIAN SELECTED**	One of these messages appears in the Language Selection Menu and confirms (after the **°C/°F** key is pressed) the operator's language selection. Refer to Section 2, Paragraph 2.6.11, and Section 5, Paragraph 5.3.12, for an explanation and a procedure to select one of the several languages available via the Message Center. Alternately, Japanese may be substituted for German and Russian.
SYSTEM INFO C/F **(SYSTEM IN FORMATION)**	This message informs the operator that the System Information Menu has been selected from the main Diagnostic Menu. Refer to Section 5, Paragraph 5.4.1, for an explanation and a procedure to select the System Information Menu.
SHOW S/W VER C/F **(SHOW SOFTWARE VERSION)**	This message appears in the System Information Menu and informs the operator that the Controller software version will be displayed when the **°C/°F** key is pressed. Refer to Section 5, Paragraph 5.4.2, for an explanation and a procedure to display the software version.
C500/550 VER 1.2 **(C500/550 VERSION 1.2)**	This message appears in the Show Software Version Menu and informs the operator of the Controller software version. Refer to Section 5, Paragraph 5.4.2, for an explanation and procedure to display the software version.
SHOW CONFIG C/F **(SHOW CONFIGURATION)**	This message appears in the System Information Menu and informs the operator how the Incubator has been configured using the Configuration Menu when the **°C/°F** key is pressed. Refer to Section 5, Paragraph 5.4.3 for an explanation and a procedure to display the Show Configuration Menu.
PRINT CONFIG C/F **(PRINT CONFIGURATION)**	This message appears in the System Information Menu and informs the operator how the Incubator has been configured will be printed when the **°C/°F** key is pressed. Refer to Section 5, Paragraph 5.4.4, for an explanation and a procedure to display the Print Configuration Menu.

SYSTEM/USER PROMPT MESSAGE	DESCRIPTION
PRINTING CONFIG **(PRINTING CONFIGURATION)**	This message appears in the Print Configuration Menu and informs the operator how the Incubator has been configured is being printed. Refer to Section 5, Paragraph 5.4.4, for an explanation and a procedure to display the Print Configuration Menu.
SHOW DIAG LOG C/F **(SHOW DIAGNOSTIC LOG)**	This message appears in the System Information Menu and informs the operator that the contents of the Diagnostic Log will be displayed when the **°C/°F** key is pressed. Refer to Section 5, Paragraph 5.4.5, for an explanation and a procedure to display the Diagnostic Log Menu.
DIAG LOG IS EMPTY	This message appears in the Diagnostic Log Menu and informs the operator that the Diagnostic Log is empty. Refer to Section 5, Paragraph 5.4.5, for an explanation and a procedure to display Diagnostic Log Menu.
PRINT DIAG LOG C/F	This message appears in the System Information Menu and informs the operator that the contents of the Diagnostic Log will be printed when the **°C/°F** key is pressed. Refer to Section 5, Paragraph 5.4.6, for an explanation and a procedure to display the Print Diagnostic Log Menu.
PRINTING DIAG LOG	This message appears in the Print Diagnostic Log Menu and informs the operator that the contents of the Diagnostic Log are being printed. Refer to Section 5, Paragraph 5.4.6, for an explanation and a procedure to display the Print Diagnostic Log Menu.
CLEAR DIAG LOG C/F	This message appears in the System Information Menu and informs the operator that the contents of the Diagnostic Log will be cleared when the **°C/°F** key is pressed. Refer to Section 5, Paragraph 5.4.7, for an explanation and a procedure to display the Clear Diagnostic Log Menu.

SYSTEM/USER PROMPT MESSAGE	DESCRIPTION
DIAG LOG IS CLEARED	This message appears in the Clear Diagnostic Menu and informs the operator that the contents of the Diagnostic Log has been cleared. Refer to Section 5, Paragraph 5.4.7, for an explanation and a procedure to display the Clear Diagnostic Log Menu.
SHOW MEM AVAIL C/F	This message appears in the System Information Menu and informs the operator the percent of memory available in the processor E^2 PROM will be displayed when the **°C/°F** key is pressed. Refer to Section 5, Paragraph 5.4.8, for an explanation and a procedure to display the Show Memory Available Menu.
MEM AVAIL = 100 %	This message appears in the Memory Available Menu and informs the operator of the percent of memory available in the processor E^2 PROM. Refer to Section 5, Paragraph 5.4.8, for an explanation and a procedure to display the Show Memory Available Menu.

3.3 THEORY OF OPERATION

3.3.1 GENERAL

This section contains a functional description and detailed theory of operation of the equipment. A system block diagram of the Controller is shown in Figure 3.2.

3.3.2 OVERALL FUNCTIONAL DESCRIPTION

The control of temperature, humidity, and oxygen concentration is achieved by means of the forced air circulation system as shown in Figure 3.1. A controlled amount of room air (approximately 35 lpm) is drawn through the air intake filter by means of the motor–driven impeller on the controller.

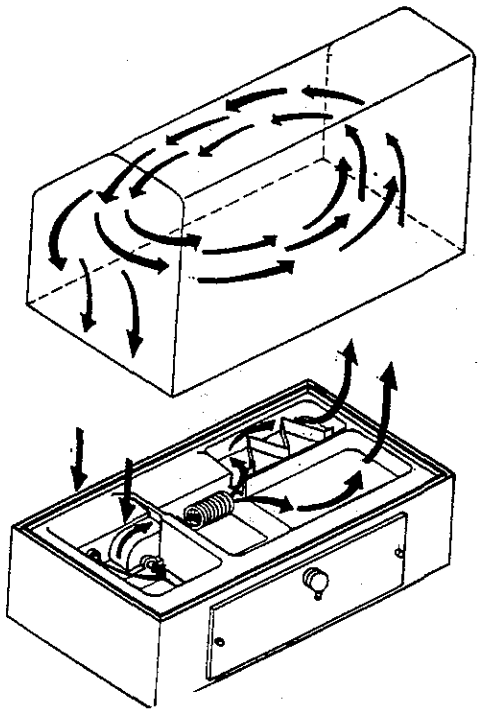
Supplemental oxygen, which may be introduced through the Oxygen Input Valve on the air intake filter cover, displaces a portion of room air to maintain the total gas intake (including oxygen) at 35 lpm. Since the amount of room air is controlled by the impeller/filter characteristics, and the amount of oxygen is controlled by the flowmeter setting, predictable oxygen concentrations within the Incubator can be attained. When oxygen flow exceeds 8 lpm, a valve within the oxygen inlet housing is activated to restrict air intake so that higher oxygen concentration can be achieved without excessive oxygen flow. Maximum air intake restriction is achieved at 12 lpm.

In addition to drawing fresh, filtered air into the Incubator, the impeller provides for the internal re–circulation at a much greater flow than that of the fresh gas inflow. The total flow of fresh and re–circulated air is directed past the air flow sensor and around the heater with a predetermined portion being directed over the humidity reservoir for humidification. When the Access Panel of the Hood is closed, the Air Curtain Cover is closed and all the air enters the infant compartment up through the slot at the right end of the main deck, as shown in Figures 3.1 and 3.1A. After circulating within the infant compartment, the air is then re–circulated down through the slot in the left end of the main deck, past the temperature sensing probe which encapsulates the air temperature control thermistor and a high air temperature alarm thermistor, and back to the impeller. When the Access Panel of the Hood is open, the Air Curtain Cover is raised permitting a portion of the air to flow upward past the opening (Figures 3.1 and 3.1A), creating a warm air curtain which minimizes the drop in air temperature in the Incubator.

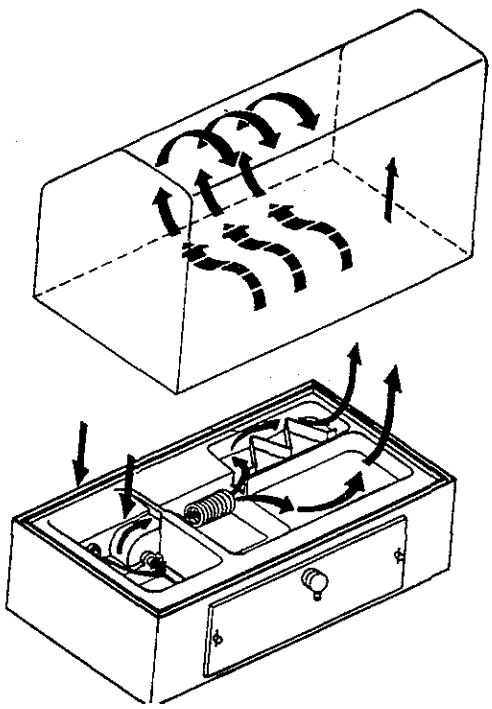
The Model C550 QT® Incubator temperature is regulated using either Incubator air or baby temperature as the controlling parameter; the desired mode is selected by the front panel keys.

In either mode of operation, the heater output is proportional to the amount of heat required to maintain the desired temperature, and the relative amount of heat being provided is indicated by the number of illuminated **Heater Power %** lights on the front panel. Changes in the number of lamps illuminated indicates the amount of power required to maintain a given temperature. During baby temperature control, the Model C550 QT® provides an indication of the degree of the infant's dependency upon the temperature of its environment to maintain body temperature. Each mode of operation is described below.

Change 5



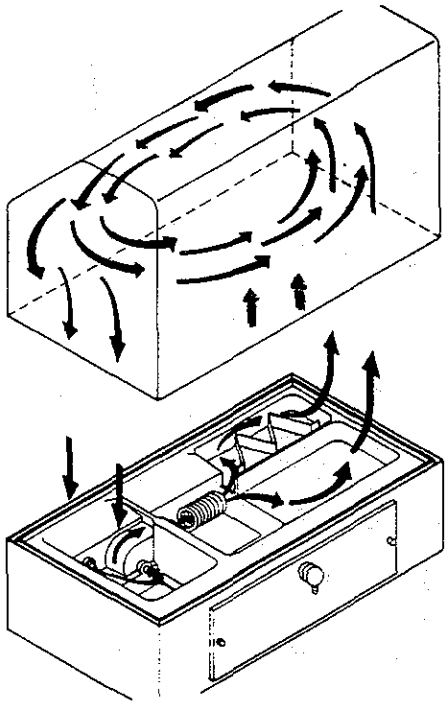
AIR CIRCULATION WITH INCUBATOR DOOR CLOSED



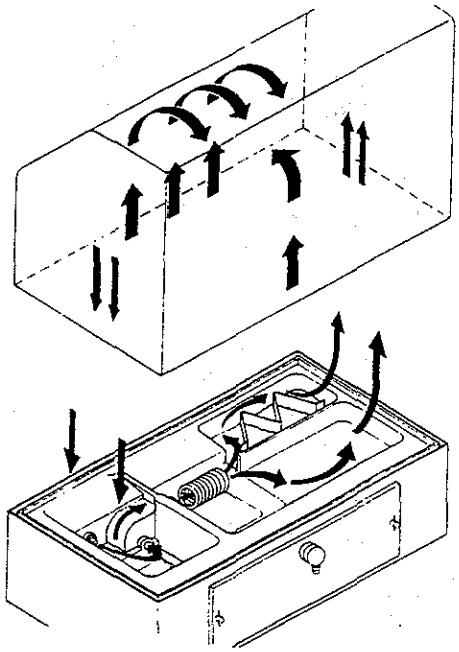
AIR CIRCULATION WITH INCUBATOR DOOR OPEN

FIGURE 3.1 AIR/O_2 CIRCULATION SYSTEM C500/C550 QT®

Change 5



AIR CIRCULATION WITH INCUBATOR DOOR CLOSED



AIR CIRCULATION WITH INCUBATOR DOOR OPEN

FIGURE 3.1A AIR/O_2 CIRCULATION SYSTEM C500/C550 QT® XL

Change 6

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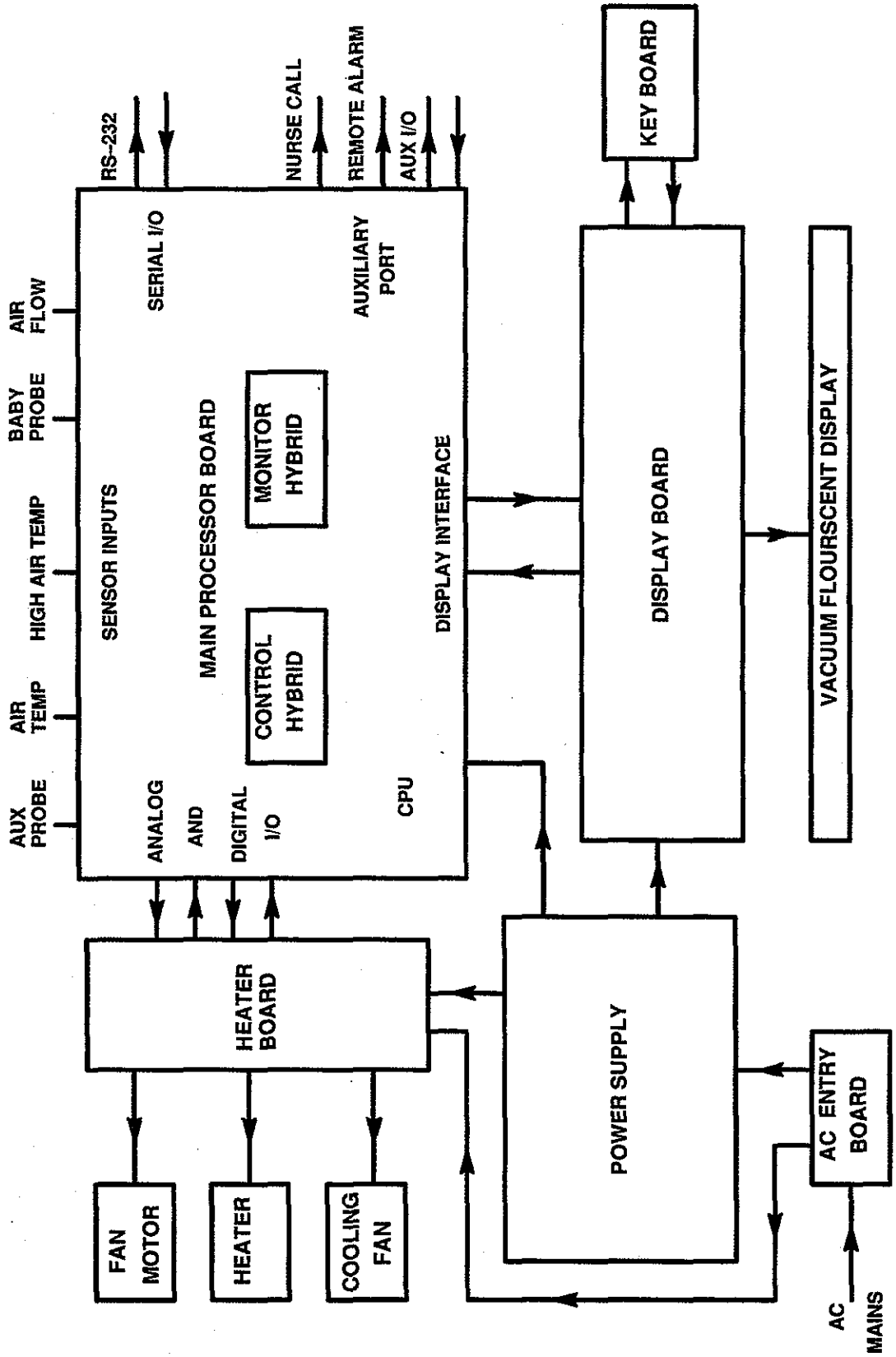


FIGURE 3.2 FUNCTIONAL BLOCK DIAGRAM

3.3.3 AIR TEMPERATURE MODE

In this mode of operation, the air temperature can be maintained from 20 to 37 °C (37 to 39 °C in Temperature Override Mode), as selected by the **Air Set Temperature** Up/Down Arrow keys on the front panel.The Incubator air temperature is monitored by a probe located below deck and compared with the Air Set Temperature setting. The information from this probe is supplied to the heater control circuitry which proportions the heater output to maintain the Air Set Temperature setting. The actual air temperature is displayed on the **Air Temperature °C/°F** Display. A second sensor within the air temperature probe serves as a backup to limit the Incubator temperature to 38 °C **(Software Level 1.8 or higher with a US Designation, the temperature will be limited to 40 °C)** for set points less than 37 °C and 40 °C for set points greater than or equal to 37 °C. At this temperature, a HIGH TEMP alarm is activated and the heater is shut off. If desired, an auxiliary air temperature probe can be used to control the Incubator air temperature. This probe is suspended above the mattress through the weighing scale hole and plugged into a receptacle on the side of the Incubator. When plugged in, the primary air temperature control probe is disconnected, but the backup sensor within the primary temperature probe remains connected. Thus, the auxiliary probe becomes the controlling element for the air temperature.

In the Air Temperature Mode of operation, the infant's temperature will be a function of the air temperature and the infant's ability to establish and maintain its own temperature. A small infant, or one with underdeveloped homeostatic control, may not be able to maintain a stable temperature at the desired level.

3.3.4 BABY TEMPERATURE MODE

In this mode of operation, the infant's temperature can be selected from 34 to 37 °C (37 to 38 °C in Temperature Override Mode) by the **Baby Set Temperature** Up/Down Arrow keys on the front panel. A temperature sensing probe is attached directly to the infant's skin; the information from the probe is supplied to the heater control circuitry which proportions the heater output to maintain the Baby Set Temperature. The Air Set Temperature does not control air temperature while in the **Baby Mode**, but air temperature is still displayed. The air temperature is still limited to 37.5 °C **(Software Level 1.8 or higher with a US Designation, the temperature will be limited to 39.5 °C)** for baby set temperatures less than 37 °C or 39.5 °C for baby set temperatures greater than 37 °C. If Air Temperature Mode has been selected while the baby probe remains connected, the **Baby Temperature °C/°F** Display will continue to display actual baby temperature, but will not control it.

If the probe is disconnected from its receptacle during **Baby Mode** of operation, the **Baby Temperature °C/°F** Display blanks, BABY TEMP PROBE FAIL appears in the Message Center, the **ALARM** Indicator illuminates and a dual tone audible alarm is activated. The High Temperature Alarm Sensor within the Air Temperature Probe remains in the circuit to limit the air temperature to 37.5 °C **(Software Level 1.8 or higher with a US Designation, the temperature will be limited to 39.5 °C)** for baby set temperatures less than 37 °C or 39.5 °C for baby set temperatures greater than 37 °C.

3.3.5 ALARMS

Alarms are provided for System Fail/Needs Service Now, Power Failure, No Air Flow, Air Temperature Probe Failure, Baby Temperature Probe Failure (C550 only), High Temperature, and temperature variation from Air or Baby Set Temperature. On power up, the Air or Baby Temperature Too Low Alarm is disabled for 60 minutes or until the temperature reaches Air or Baby Set Temperature, whichever occurs first; each of these alarms is described below.

NOTE: *The Controller has five different Audio Alarm Tones available. Refer to Section 2, Paragraph 2.6.3, to select an Audio Tone.*

NO AIR FLOW

A sensor located below deck in the normal air path of the fan controls this alarm. If air flow stops due to a fan failure, the temperature of the self–heated sensor rises which causes the NO AIR FLOW Message to be

displayed in the Message Center and the **ALARM** Indicator illuminates with an audible tone. A short–circuited air flow sensor failure will also actuate the alarm within 9 to 18 seconds of the occurrence of the failure. This alarm is not self–resetting, but can be silenced by the **Silence/Reset** key for a period of 5 minutes.

HIGH TEMPERATURE

A second sensor within the Temperature Probe sounds this alarm if the Incubator temperature reaches 38.0 °C (40.0 °C for >37 °C Mode) (40.0 °C for 1.8 software or higher with U.S. designation). The HIGH TEMPERATURE Message appears in the Message Center and the **ALARM** Indicator illuminates along with an audible tone. This alarm is not self–resetting, but can be silenced by the Alarm **Silence/Reset** key for a period of 5 minutes.

POWER FAILURE

If primary power to the Incubator is interrupted for any reason, including a disconnected power cord, an audible alarm is activated and the **POWER FAIL** Indicator lights. This alarm can be deactivated by restoring the primary power, setting the Incubator **POWER** switch to Off, or pressing the **Silence/Reset** key.

SYSTEM FAIL/NEEDS SERVICE NOW

If an internal system failure occurs, the **SYSTEM FAIL** Indicator lights, NEEDS SERVICE NOW appears in the Message Center and the audible alarm sounds, the unit should be referred to service.

AIR TEMPERATURE PROBE FAILURE

Circuitry is provided to monitor the air and high temperature sensors for short–circuited, open–circuited, or disconnected conditions and the air flow sensor for open condition.

AIR TEMP PROBE FAIL appears in the Message Center, the **ALARM** Indicator light illuminates and an audible alarm sounds within 9 to 18 seconds to indicate a defective air temperature or auxiliary air sensor.

BABY TEMPERATURE PROBE FAILURE (C550 QT® only).

Circuitry is provided to monitor the baby sensor for short–circuited, open–circuited, or disconnected conditions.

BABY TEMP PROBE FAIL appears in the Message Center, the **ALARM** Indicator light illuminates and an audible alarm sounds within 9 to 18 seconds to indicate a defective baby sensor. This alarm is active only in **Baby Mode.**

AIR OR BABY TEMPERATURE TOO LOW or AIR or BABY TEMPERATURE TOO HIGH

The Air or Baby Temperature Too Low or Air or Baby Temperature Too High Alarm is actuated if the baby or air temperature fluctuates from the set temperature as follows:

Baby Temperature (C550 QT® only)	+1.0 ± 0.3 °C
	–1.0 ± 0.3 °C
Air Temperature	+1.5 ± 0 °C
	–2.5 ± 0.5 °C

A temperature below the Air or Baby Set Temperature is indicated by AIR or BABY TEMP TOO LOW in the Message Center, the **ALARM** indicator on, an audible alarm, and a low temperature reading. A temperature above the Air or Baby Set Temperature is indicated by AIR or BABY TEMP TOO HIGH in the Message Center, the **ALARM** indicator on, a pulsating audible tone, and a high temperature reading.

The Air or Baby Temperature Too High or Too Low Alarms are self–resetting; that is, if the alarm condition is corrected, the audible alarm is automatically silenced and the visual alarm indicator is turned off.

Change 4

The audible portion of the Air or Baby Temperature Too High or Temperature Too Low Alarm can be silenced by pressing the **Silence/Reset** key; the activation of other audible and visual alarms will not be affected by use of the 10–minute audible alarm silence. When the alarm is silenced, the alarm lamp will remain on until the alarm condition is corrected. If the alarm condition is not corrected within 10 minutes, the audible alarm will be reactivated.

An Air Temperature Too Low Alarm will occur while operating in Baby Temperature Mode, if a "room temperature" Auxiliary Probe is placed into a "warm" Incubator. The alarm is indicated by the message AIR TEMP TOO LOW, the **ALARM** indicator being on and a continuous audible tone. The alarm is self–resetting and the audio portion can be silenced for 5 minutes (to allow the probe to warm up).

Specifically, the AIR TEMP TOO LOW Alarm will occur if the Incubator air temperature in **Baby Mode** is equal to or greater than 37 °C (for **Baby Set Temperature** <37 °C) or 39 °C (for **Baby Set Temperature** ≥ 37 °C) and an Auxiliary Probe temperature of 2 °C below the Incubator air temperature.

Please note that this function is only for **Baby Mode** of operation. If a cold Auxiliary Probe is placed into a warm incubator while in the **Air Mode**, the NEEDS SERVICE NOW message appears.

IMPORTANT: *Even though an alarm is instituted, it should be noted that the heater will be full on due to the fact that the Auxiliary Probe is cold and calling for full heat. If left unattended, the* ***HIGH TEMPERATURE*** *Alarm will activate at 38 °C (for* ***Baby Set Temperature*** *<37.0 °C) or 40 °C (for* ***Baby Set Temperature*** *≥ 37.0 °C) to limit the internal temperature to an acceptable level. For* ***Software level 1.8 or higher with a US Designation,*** *the* ***HIGH TEMPERATURE*** *Alarm will activate at 40 °C for any* ***Baby Set Temperature*** *.*

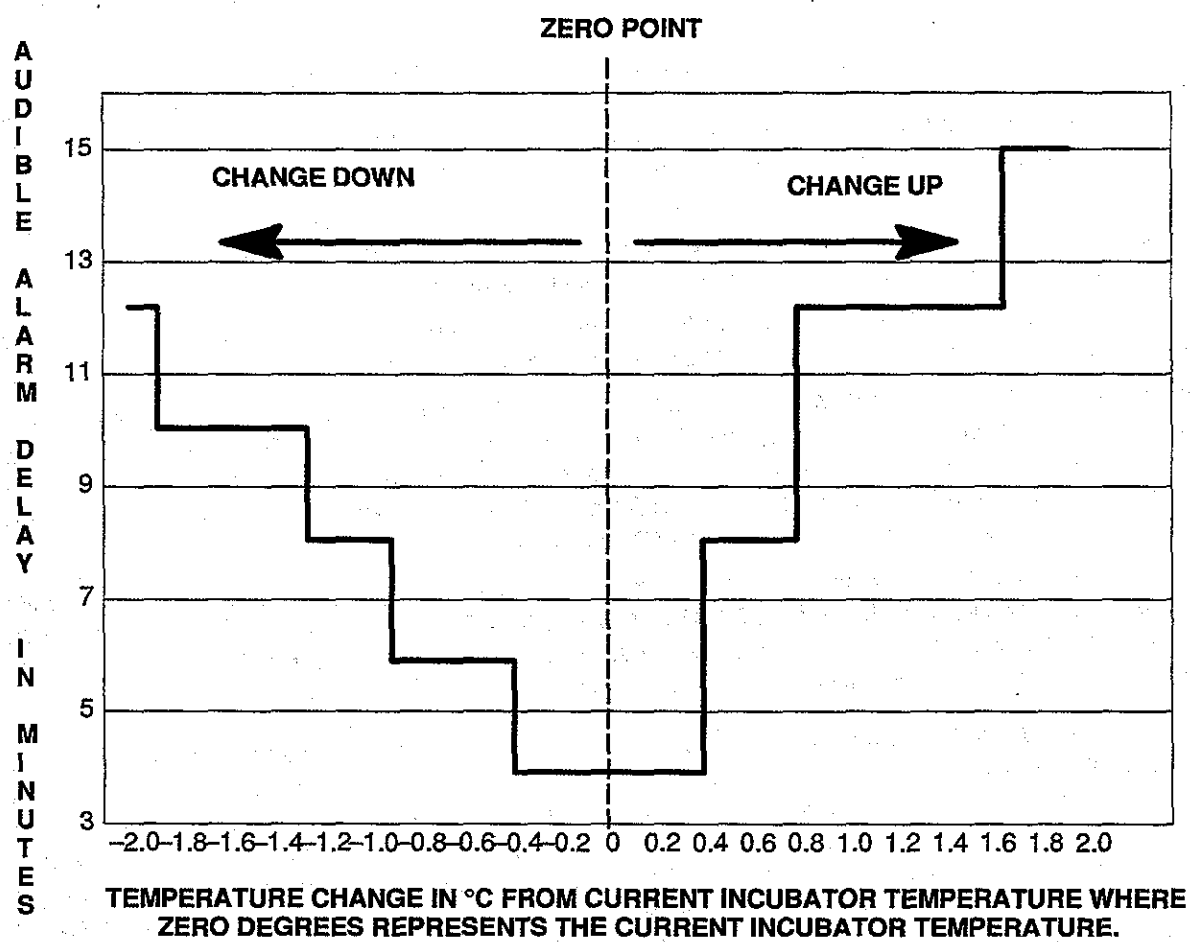
CAUTION: Any time that the Auxiliary Probe is plugged into the Controller, it should be placed into the Incubator and allowed to stabilize for a MINIMUM OF 5 MINUTES prior to insertion into the Controller. This will not only prevent false alarms, but will also reduce the thermal change when switching from below deck to the auxiliary temperature probe control.

In addition, if it is desired to change the Air or Baby Set Temperature (either high or low) after the Incubator is in operation, the Temperature Too High and Temperature Too Low Alarms are automatically silenced for a specific amount of time after the operator raises or lowers the Air or Baby Set Temperature from the current operating temperature. The time the alarm remains silent varies with the amount of change (either plus or minus) from the current Incubator temperature. As a general rule, the greater the change from the current Incubator temperature, the longer the alarm will remain silent. If the Incubator fails to reach the new set temperature after the specified time, the alarm will sound. Refer to Figure 3.3 for specific times the alarm is silenced versus the amount of degree change from the current Incubator temperature.

Alternately, before changing the current Air Set Temperature, the operator may press the **Silence/Reset** key to place the unit in the Procedural Silence Mode of operation. In the Procedural Silence Mode, the Temperature Too High and Temperature Too Low Alarms are silenced for up to 15 minutes. Refer to Section 2 for setting the procedural time duration. To leave the Procedural Silence Mode, press the **Silence/Reset** key again.

REMOTE ALARM MODULE (ACCESSORY)

A Remote Alarm Module (Accessory) can be mounted atop an I.V. Pole (refer to Figure 1.1) to provide a visual indication that an alarm condition is in progress or has occurred.


ZERO POINT
AUDIBLE ALARM DELAY IN MINUTES
15
13
11
9
7
5
3
CHANGE DOWN
CHANGE UP
–2.0 –1.8 –1.6 –1.4 –1.2 –1.0 –0.8 –0.6 –0.4 –0.2 0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0
TEMPERATURE CHANGE IN °C FROM CURRENT INCUBATOR TEMPERATURE WHERE ZERO DEGREES REPRESENTS THE CURRENT INCUBATOR TEMPERATURE.

EXAMPLE: If the current Incubator Air Temperature is 36 °C (Zero Point) and the Operator raises the Air Set Temperature from 36 °C to 37.4 °C (a change up of 1.4 °C), the activation of the audible alarm will be delayed for 12 minutes.

FIGURE 3.3 TEMPERATURE TOO HIGH AND TOO LOW ALARMS – AUDIBLE ALARM DELAY TIME VERSUS CHANGE FROM CURRENT INCUBATOR TEMPERATURE

3.4 DETAILED CIRCUIT DESCRIPTION

3.4.1 AC ENTRY BOARD (REFER TO FIGURE 7.3)

GENERAL

The ac Entry Board provides ac power distribution for the series C500/550 Incubator Controllers. The printed circuit board may be configured for either 100/120 or 240V configurations, depending on the assembly.

AC MAINS INPUT

AC Mains voltage is inputted to the controller via J4, which is a combination IEC–350 type input receptacle and integrated EMI line filter. The third wire–protective ground termination is terminated from the receptacle directly to chassis ground. Protection against excessive current draw by the controller is provided by circuit breakers CB1 and CB4. The circuit breaker CB2 is installed (R1–R3 removed) only for European versions of the controller where protection in both sides of the line (hot and neutral) is required. In the case of non–European versions, CB2 is removed and R1–R3 are installed to maintain circuit continuity.

The ac voltage is applied to S1 pins P2 (ac hot) and P1 (ac neutral), which provides ON/OFF control for the system. The switched ac voltage at pins S1–2 (switched ac hot) and S1–1switched ac neutral) is then routed to J2–5 and J2–3 to provide power to the Power Supply Board and J3–1 and J3–3 to provide power to the Heater Board.

Functional ground connections required for the Power Supply Board are connected via the chassis mount screw terminations at E1 and E2 and are passed to the board via J2–1.

DC CIRCUIT

AC Mains Switch S1 contains an integral 24Vdc illuminated section which is illuminated when the switch is in the ON position and 24Vdc is applied to J1–1 (PGND) and J1–2 (+24V).

An additional set of switch contacts is connected to J1–3 (VSW and J1–4 (VBAT) which is used in the system to switch in the backup power supply for power failure.

3.4.2 HEATER BOARD (REFER TO FIGURE 7.4)

AC LINE MONITORING

AC line voltage is applied to the primary of the transformer T1 via protective circuit fuse F1. Secondary voltage is rectified by CR3 bridge and filtered by C6. Filtered voltage then is tapped off of R27 and applied to the non–inverting amplifier U4–8. The output U4–7 represents a scaled ac voltage and is always adjusted by R27 to 6.00 VDC at nominal ac line voltage.

DC MOTOR CONTROL

The motor control circuitry is designed to operate a 3–phase, 4–pole dc brushless motor which is used for air circulation in the Incubator. The dc motor is connected to the board via J4. Resistors R6, R19 and filter capacitor C3 are supplying power to the motor internal HALL effect position sensors. The differential analog outputs of the sensors are coming from J4–7 to J4–12, digitized by comparators U2A, U2B, U2C and applied to the inputs U3–7, U3–9 and U3–8 of the motor–driver chip U3. This chip provides all necessary decoding and commutation of the motor windings. The R22 resistor sets absolute maximum motor current to 2A. Motor velocity information is derived from the output U2–2. It represents a pulse train whose frequency is proportional to the motor's angular velocity. An F to V (frequency to voltage) converter is built around U1A, U1C, RN2E, RN2B, C5, CR1 and C4. The voltage at TP3 represents the motor's actual velocity. A reference motor velocity voltage is set by trim pot R26. Differential amplifier U2D compares these two signals and applies an error signal to the U3–4 input via resistor divider R17, R18. U3 then PWM (pulse width modulates) an output current to the motor winding, thus maintaining motor speed equivalent to the set point.

POWER OK CIRCUITRY

This circuitry checks that ac power is present in the event of F1 fuse tripping. The voltage at the J1–4 will be maintained by the diodes CR5 or CR6 above 4.4 VDC level when either +5V or +6V (AC–VOLT) is present. If both voltages are not present, it means that there is no ac power supplied to the Incubator and POWER FAIL alarm will be activated.

AC OK CIRCUITRY

This circuitry verifies that AC–VOLT signal is valid and fuse F1 is OK. Normal voltage level at J1–2 is maintained by the ZENER diode CR7 and equal to 5.1 VDC. When F1 is blown, capacitor C6 is discharged through R27 and the voltage at J1–2 falls to 0V level.

OVERHEAT DETECTION

The purpose of the overheat detector circuit is to send an alarm signal (OVHEAT) to the main CPU board when the internal air temperature of the C550 rises above a predetermined temperature and, conversely, deactivate, the alarm signal when the temperature returns to an acceptable level. Hysteresis is incorporated in the design and hence the **OVHEAT** signal will become active before the temperature reaches 60 degrees C and will subsequently deactivate when the temperature drops below 50 degrees C.

The circuit is basically a comparator that measures the voltage across thermistor RT1. As the temperature rises, the resistance of RT1 decreases, as does the voltage across it. When the voltage reaches the reference voltage at pin U4–3, the output U4–1 will go high, U1–8 and J1–10 (OVHEAT) will go low, and U1–10 will go high. This will increase the reference voltage at U4–3, shifting the threshold temperature to a lower value.

3.4.3 MAIN BOARD (REFER TO FIGURE 7.5)

GENERAL

The Main PWA for the C500/550 Controller comprises the functions of temperature measurement, signal conditioning and conversion, display output control, user interface, an alarm generation through the use of hardware and software functions.

POWER SUPPLY

AC ENTRY

Voltage required to illuminate the power switch on the AC Entry PCB is via +24VDC connected to J9–2 and ground at J9–1. Battery voltage switching required for power failure alarm is routed out to J9–4 and comes back into the main board at J9–3.

DC SUPPLY

Power for the board is via connection to J1, which provides isolated voltages of +5V, +/–12V and +24V. Isolated –5VDC is also board generated by VR1, which makes use of –12V to generate the desired output.

MICRO–CONTROLLER

GENERAL

The uC U1 is used to interface to all user parameters, perform set point generation and monitor hardware functions/activity.

DATA BUS

The bi–directional data busses D0–D7 are active on pins 9–16 and are bussed to the program memory U2, hybrid interface buffer U11, display select buffer U4, display board interface buffer U7, and real time clock/RAM chip U19. The data bus is pulled up by resistor network RN4.

ADDRESS BUS

The bi–directional address busses A0–A7 are active on pins 51–58 and A8–A15 are active on pins 43–50. The address lines are bussed to U2 to access program memory, real time clock/RAM U19 and hardware decode logic PAL device U3.

CONTROL LINES

Control lines for I/O devices are located on U1–4 which is the enable line and U1–5 which is the R/W control signal.

PORT A

General purpose port A (pins 35–42) is used as I/O interface signals. LED–TEST is active when the uC is doing LED testing, ALM–SIL2 is active when the uC is silencing alarms (which is logically equivalent to the signal ALM–SIL from U11–12), OVHEAT–B which is a buffered input from the heater PCB, digital pot interfacing (pins 37–39), AC–OK coming from the heater board to indicate whether the circuit breaker has tripped and MOT–RPMB which is a frequency proportional to the motor speed.

PORT G

Port G (pins 20–27) is also used as I/O functions. The SOUND line is an audio drive signal to the alarm logic PAL U15. DIAG–F line is active when the uC senses internal or external problems. BUSY–B is used as the busy sense line return from the VFDM. KYPD is used to enable the keypad read on the front panel switches by the uC. SEL–DSPL is used to enable display select lines for the display PCB. HW–SEL is used as the select line for hardware I/O functions read (or written) by the uC. CLOCK is used for data I/O into U19. PROM is used as the program memory select line.

SERIAL COMMUNICATIONS

Serial communication signals appear as receive data into the uC (RXD pin 28), transmitted data out of the uC (TXD pin 29), serial data out from the monitor hybrid (MISO pin 30), serial data into the control hybrid (MOSI pin 31) and serial clock required for MISO and MOSI (pin 32).

A/D CONVERTER

The uC contains 8 channels of analog inputs which are A/D converted internally (pins 59–66). HITEST is a logic level input to determine whether the ring out probe is attached. HTR–EN is a logic signal indicating if heater is enabled. BAT–SENSE monitors the power failure backup power source as shifted by RNGD, E. HEAT–PWR is a relative indication of heater power where +4V equals full heater and OV is < 25 % heater power. Pin 60 senses both the +24V supply and –12V supplies. Pin 62 senses both the +12V and –5V supplies. AUX–ANLG provides an auxiliary input from J5. DEFAULT is used to sense whether power down was a result of switch depression or ac failure.

The internal A/D requires a positive and negative voltage reference for analog conversion, and these voltages are inputted to pins 68 and 67 respectively.

SUPPLY VOLTAGE

The uC is powered from pin 34 (positive supply + 5VDC) and ground reference at pin 1 and filtered by C7. All uC timing and signal generation is derived from the 8.0 MHz clock oscillator input at pin 6 from Y1–5. Pin 1 of Y1 is tied high to enable the oscillator.

INTERNAL OPERATION MODES

The uC internal operational modes and unused inputs are pulled high by RN1 at the pins U1–2,3,17,18,19.

DATA BUS PERIPHERALS

Program Memory: Program Memory for the uC operation is stored in U2. The chip is addressable up to 64K bytes with the bus width of 8 bits. The chip enable is developed from U1–20 and the output data is strobed onto the bus with the RD signal at pin 22.

RAM/Real Time Clock: Provision is made on the PWA for a real Time Clock and RAM chip (U19). The RD or WR control signals are used to input or output data from/to the device.

Watchdog Timer: Watchdog Timer U12 is used to monitor the uC activity. The signal on U12–7 is generated as a toggled line via PAL U3–17. If this line fails to "toggle" within a predetermined time limit, U12–6 becomes active which is fed into the PAL U3. Four successive watchdog signals will cause U3–18 to be asserted as a hardware failure. This device also generates the power up reset signal required by the uC and alarm logic clock/counters.

Decoding Logic: PAL U3 is wired to the address lines of the uC to map signals required for I/0 interfacing. U3–21 (W–A/D) is used as the chip select for the buffer driving various outputs. Pin 20 (ANALOG) is used as the chip select for the buffer U8 which provides interfacing to the alarm logic levels. Pin 19 (DSPL) is used as the chip select for the display buffer U7 I/O. Pin 17 (WDT) is used to toggle the Watchdog Timer U12.

BUFFERS

Intra–Board Signals: Various signals are buffered within the main PWA for level conversion,interfacing, etc. IC's to provide these are buffer/driver chips U20 (hybrid to PAL), U8 (PAL to uC), U11 (uC to hybrids and PAL'S) and U6 (signal to signal).

Inter–Board Signals: Signals in/out of this PW going to other PWAs (heater board, display, etc) are buffered as a method to insure reliability by buffer/driver chips U4, 5 & 7 (uC to display PWA).

TEMPERATURE INPUTS

HYBRIDS

Monitor Hybrid: The monitor hybrid U21 is a single chip solution which provides temperature measurement interfacing to the uC. The hybrid contains an analog to digital converter which is under uC control via the control lines CONVST (U21–30), SCLK (U21–32) and MISO (U21–38). Internal to the hybrid is an analog multiplexer, which is controlled via lines CHSO, 1, 2 (U21–11, 7,16).

Logical inputs to U21 consist of AIR–MODE (U21–21) which is active for air mode control selected and GT37 (U21–23) which is active when a set point temperature in excess of 37 Degree C is selected.

Measured temperature set point data is inputted to U21–10 which has a signal of –0.2V/Degree C.

Temperature data are inputted to U21 from thermistors and are located at the following pins:

- U21–19 Auxiliary Probe Monitor
- U21–25 High Temperature Probe
- U21–8 Skin Probe
- U21–3 Air Flow Probe

Alarm levels are detected internally and outputted as a logic state as follows:

- U21–33 Probe Failure
- U21–36 High Temperature Probe Failure
- U21–31 Air Flow Probe Failure
- U21–39 Air Flow Alarm

Precise temperature measurement is accomplished by incorporating a precision internal voltage reference which is outputted at U21–27.

The signal HTR–LIMT (U21–5) provides an output which is used in the control hybrid as an air temperature limit set for either 37.5 Degree C or 39.5 Degree C. AIR–CTRL (U21–1) and SK–CTRL (U21–2) is converted by the internal A/D which allows the uC to also monitor the control temperatures outputted from the control hybrid.

SK–MON (U21–15) is a signal proportional to the skin temperature input (0.2V/Degree C) and air temperature is inputted at U21–9 as either auxiliary air temperature (U21–28) or normal air temperature.

Control Hybrid: The control hybrid U22 is a single chip solution for temperature control. The control set point T–SET (U22–31) is generated by the internal digital to analog converter under uC control via the control lines MOSI (U22–24), DTOA (U22–23) and SCLK (U22–22).

Selected control mode is inputted at U22–19. For air mode control, the thermistor connected to U22–35 will provide temperature control. For skin mode control, the signal connected to U22–32 will provide skin temperature control. Skin temperature control output signal is present at U22–34 with a signal equal to 0.2 V/Degree C.Air temperature control signal is present at U22–37 with a signal equal to 0.2V/Degree C.

Automatic heater power control is internally conditioned with a signal provided at U22–20, which is a dc voltage proportional to the ac line voltage.

In the internal control section, capacitance across U22–2 and U22–3 provides the integral term in the control loop. Additional capacitance to ground at U22–7 sets the pulse width modulated frequency for the solid state relay control outputted at U22–1.

Solid state relay cutout is controlled though a logical signal that can be inputted at U22–10. Additionally, alarm generation for air temperature too low alarm (U22–16) and air temperature too high alarm (U22–17) is generated in this hybrid.

A voltage at pin U22–5 sets the high air temperature limit to either 37.5 Degree C or 39.5 Degree C as sensed by the probe signal at U22–4.

A dc voltage proportional to the heater power is outputted at U22–8 and has the approximate range of 0–4VDC.

Calibration Check (Hybrids): Calibration of the hybrids can be confirmed by activation of the CALCHK line inputted to relay driver Q1–gate. When active, relay K2 switches precision resistors R10–13 corresponding to temperature values of 35.9 & 40.0 Degree C into both hybrids, allowing a software check of the hardware.

PROBES

AUXILIARY TEMPERATURE

The dual auxiliary probe can be inputted to the board via connection to J4. Switch S1 is mechanically linked in such a manner that when the dual auxiliary probe is connected to J4, the switch is activated. The switch is used to "multiplex" the auxiliary thermistor information to both the monitor and control hybrid instead of the normal below deck thermistor. EMI filter LN1 is used to reduce EMI radiation & susceptibility.

DUAL AIR

The high temperature thermistor section of the dual probe is connected to J7–1 and is always used to monitor temperature and high temperature alarm conditions except during calibration check. The alternate thermistor is connected to J7–3 and is normally connected to the control hybrid unless it is switched out by S1 in the event of auxiliary probe connection.

SKIN

The skin probe connection is made through J3–1 and J3–3 and is always connected to the monitor hybrid unless switched out during calibration test. EMI filter LN2 is used to reduce EMI radiation & susceptibility.

AIR FLOW

Air flow probe thermistor is connected to J6–1, 2 and is operated under self heated mode. A constant current source generated by R15, 16, Q2 and CR6 of a nominal 20 mA is used to shape the response of the thermistor. Thermistor input is into the control hybrid.

INTERFACE CIRCUITS

DISPLAY BOARD

Power for the Display Board (+5V and digital ground) are brought out on multiple pins on J1 to reduce IR drops from the current load of the display drivers. The +12V voltage is provided on J1–21 to drive low current devices on the display PCB. The power fail battery voltage comes into J1–27 (VBAT) and is routed out to J9–4 which is connected to an auxiliary contact on the Mains Switch. The other auxiliary contact of the Mains Switch is connected to J9–3 (VSW) which is routed to J1–31. These signals provide the power fail alarm logic voltages required. Additionally, the signal VSW is level shifted by RN9D & RN9E and fed into an A/D input of the uC U1–63 (BAT–SENSE). The signal DEFAULT (J1–23) is fed into the uC and is used to determine if power failure was a result of Mains Switch activation or other type of failure (cord disconnect, etc.).

The uC data bus lines D0–D7 are buffered through U7 and appear as the lines B0–B7 on J1. These signals are used to drive the VFDM connected to the Display Board. The signal FUTWR B (J1–36) comes from buffer U6 and is used as the VFDM write signal. The signal DIS–B (J1–40) is buffered by U6–16 and provides the select signal required by VFDM. The signal BUSY (J1–42) is returned by the VFDM and is used by the uC to determine whether the device is busy or ready for data.

Interfacing to all display board elements is through the display enable signals EN1–EN6 which are decoded and buffered signals from U4. These signals provide the select function for the Display Board driver ICs. Data input to the Display Board drivers is via serial transmission by the signals MOSI–B (J1–22) and SCLK–B (J1–24) which are buffered out of U5.

Interfacing for the digital potentiometers on the Display Board is by the buffered signals from U5. A–LOAD–B (J1–26) is the selected signal, A–DATA–B (J1–28) is the serial data and A–CLK–B (J8–30) is the serial clock.

HEATER BOARD

Interfacing to the Heater PCB is via J2, which contains voltages required to drive the motor and signals back from the heater PCB to indicate status. The logic signal AC–OK (pin 2) is sensed by the uC to determine if the heater board protection circuit has tripped. Logic signal PWR–OK (pin 4) is used as the flag for power failure. Logic signal OVHEAT is a flag read by the uC to determine if the cooling fan is not providing sufficient cooling. MOT–RPM is a signal whose frequency is proportional to the motor speed. AC–VOLT is a dc signal which is proportional to the applied ac input line voltage and is used by the hybrids for heater power line voltage compensation. Heater control is via logic signal HTR–CUT, which, when active, disables the heater, and the signal SSR–CTRL, which is used as the pulse width modulated input to the solid state relay on the heater PCB.

SERIAL COMMUNICATIONS

The external SERIAL PORT J10 provides isolated serial RS–232 communications for transmitting and receiving serial data. Transmit data appear on pin 3 and receive data appear on pin 2. All other signals are tied to the active state (positive RS–232 levels) for interfacing. EMI filter LN6 is used to reduce EMI radiation and susceptibility.

The combination chip set of U9 and U10 (along with associated components) provide drive and conversion signals for the isolated channel. U9 interfaces directly to U1–28, 29 for receive and transmit data. U9–2,13 provide the drive capability to drive isolation transformer T1 which provides isolated power for U10. U9–3 is the transmit out line which drives opto–isolator U18 providing an isolated transmit line for U10–3. U9–10 is the receive input from the opto–isolator U23 which provides isolated received data from U10–5. Components CR1, C3 and C4 are used to rectify and filter the power signal from T1 and provide positive and negative isolated voltage levels required for communication.

The external SERIAL PORT J10 is connected as a DTE device with additional pins connecting signals required for the SSR control. Note that the SERIAL PORT signals are electrical isolated from the SSR control signals. The following Table provides pin connections along with a description:

Pin #	Pin Name/ Description	I/O	Levels
1	Data Carrier Detect	Input	Not Used
2	Receive Data	ISO Input	RS232
3	Transmit Data	ISO Input	RS232
4	Data Terminal Ready	ISO Output	RS232
5	Isolated Ground	ISO Gnd	
6	Data Set Ready	Input	Not Used
7	Request To Send	ISO Output	RS232
8	Clear to Send	Input	Not Used
9	Ring Indicator	Input	Not Used

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MULTI–PURPOSE OUTPUT

Remote Alarm Module (RAM): Connections made to the RAM are J5–1 to J5–6. Pins 1 and 5 are used to redundantly provide audio drive for the RAM. Pin 2 is the visual enable for the LEDs and pin 4 (MUTE) is a signal that, when asserted, silences the internal speaker. EMI filter LN3 is used to reduce EMI radiation and susceptibility.

Nurse Call: Connections are provided on J5–7, 8 as a contact closure for the Nurse Call option from K1 whose coil is driven by the signal N–CALL from U15–20. EMI filter LN4 is used to reduce EMI radiation & susceptibility.

Auxiliary: Connections are provided on J5–9 to J5–12 for signals into the system. J5–9 and J5–12 are power connections, J5–10 is an auxiliary digital input to the uC and J5–11 is an auxiliary analog signal into the uC. EMI filter LN5 is used to reduce EMI radiation and susceptibility.

If internal auxiliary connections are required, LN5 will be replaced by J11.

ALARM LOGIC

GENERAL TIMING

Alarm logic timing for alarm delays is provided by CMOS oscillator comprised of U17B, C,D which is set to oscillate at a nominal 3.3 Hz rate. This signal is fed from U17–8 into the divider U13, which provides reduced timing rates for the alarm logic. Power on reset is inputted to divider U13 to insure proper startup counter reset.

ALARMS

Delay: Asynchronous alarm delays are conditioned by programmable logic device U14, which internally generates the alarm delay for set point (U14–17), a logic output to indicate the 1 hour set point alarm disable time has expired (U14–14) and a logic out to enable the heater for temperature control (U14–16). Logical combinations are provided at U14–18,15 for alternate PAL logic control.

Set Point: Set point alarms are sensed, delayed,and logically conditioned by the programmable logic device U15. The signal ALARM–0 (U15–19) provides logic output to enable audio tones. The logic state for set point high alarm is outputted at U15–17 and set point low alarm level is outputted at U15–16.

Inputs to this device include CLK (U15–1) to generate internal time functions, LERR (U15–2) to indicate whether a latched alarm is active, ALM–SIL (U15–3) and ALM–SIL2 (U15–23) are used to silence the audio and HW–F (U15–11) are used to determine if hardware failure has occurred.

3.4.4 DISPLAY BOARD (REFER TO FIGURE 7.6)

GENERAL

The Incubator has two versions, the C500 and the C550. Both models are essentially the same with the C500 being a subset of the C550. The Display Board of the C500 has all the display LED's as the C550 with the exception of the following displays and their corresponding drivers:

C500 equals the C550 without:

- Baby Temperature
- Baby Control Temperature
- Baby Mode
- Baby Mode Degree C/F

The function of the Display Board is to provide the Incubator with the following:

- Displays of temperature and other system information for operator interface purposes.
- Interface circuit for the Keypad.
- Alarm detection and annunciation including audio amplifier, tone control, and speaker.
- Battery, including charging circuit, to support alarm after normal power has failed.

POWER SUPPLY

The power required to run the Display Board is normally provided by the Incubator's main power supply. The Display Board only requires +5 and +12 volts dc and circuit ground from the main supply.

BATTERY SUPPLY

A battery is employed on the Display Board to power the audio alarm and its supporting logic in the event of main power failure. The battery is a Nicad rechargeable type that is charged by a circuit on the Display Board.

ELECTRICAL SPECIFICATIONS:

Capacity: 100 milli–amperes hours

Voltage: 4.8 volts

CHARGING CIRCUIT

The charging circuit consists of the following components:

U17A, U8C, U8D, CR4, CR5, R16, R23, R18, R20, R15, R21, R22, and RN5B.

The battery, BT1, is connected to the charging circuit through an isolated connection in the power switch. The switch connects VBAT with VSW, the junction of R23 and R21.

The basic function of the circuit is to charge the battery to about 6 volts. The minus input, pin 4, of comparator U17A is held at a reference voltage of about 5.7 volts. The battery voltage is applied to U17A pin 5 via R21. To eliminate the possibility of oscillation, hysteresis is added through R22.

When the battery is discharged, the voltage at U17A pin 5 is below that of pin 4 and pin 2 is low. A low on pin 2 results in a low on the gate of transistor U8C, turning it on. This supplies charging current to the battery through the channel of the transistor, diode CR4, and resistor R23. When the battery voltage surpasses that on U17A pin 4, pin 2 of U17A goes high, transistor U8C turns off and current to the battery is cut off. A small trickle charge, however, is always present because of resistor R16.

DISPLAY DRIVERS

All of the displays on the board are common anode. In all, except the System Fail and Power Fail Displays, the common anode is connected to the +5 volt supply through a two–diode drop that reduces the supply to about +3.8 volts. The segment cathodes are driven to ground by a National MM5450 display driver.

The MM5450 is a serial input, parallel latched output LED segment driver. When the enable is pulled low, serial segment drive data are clocked into a serial shift register in the device. When the latch is full, all the data are transferred to the latch/driver on the next clock pulse.

All three interface signals (enable, data, and clock) are provided by the main controller board.

The System Fail and Power Fail light bars are controlled in a different manner. Their anodes are connected to either +5 volts or the battery through a FET. This is done so that they can be driven even when the +5 has been removed.

DISPLAYS

Only LED displays are used on the Display Board. Of these displays, there are two types; one is the numeric seven–segment type and the other is a light bar type.

KEYBOARD INTERFACE

The Incubator keyboard switches are arranged in a column/row matrix. Consequently, the keyboard scan circuitry drives the columns and reads the rows. There are two columns, COL–A and COL–B, and 6 rows labeled ROW–A through ROW–F.

The column drivers are provided by signal KYPD–B and 74LS05 inverters U7A, U7B, and U7C. When KYPD–B is driven high by the main board micro–controller, COL–A is driven low while COL–B is driven high. Since the output of 74LS05 is an open collector, pull–up resistors RN1 are needed. The row information is latched into U9, 74HC541, when signal R/W–B is driven high by the main board micro–controller.

The corresponding row output information, BO–7, is available on connector J1 pins 46,48,50,....60. Resistors RN2 provide static discharge protection.

SECTION 4
PREVENTIVE MAINTENANCE

4.1 GENERAL

This section provides cleaning and maintenance instructions. Where necessary, disassembly instructions are provided.

WARNING: Make sure that the oxygen supply to the Incubator is turned off and that the Incubator is disconnected from the oxygen supply when performing cleaning and maintenance procedures; a fire and explosion hazard exists when performing cleaning and/or maintenance procedures in an oxygen-enriched environment.

4.2 CLEANING

At a minimum, the incubator should be thoroughly cleaned and disinfected upon discharge of an infant. Cleaning can most effectively be accomplished by disassembling, then grouping the parts and/or assemblies in categories according to the method of cleaning required.

4.2.1 DISASSEMBLY FOR CLEANING

NOTE: *For routine cleaning there is no need to separate the Hood/Base Assembly from the Cabinet Stand. If separation is necessary, refer to the Installation Section.*

WARNING: The Controller heater can be sufficiently hot to cause burns; avoid removing the Controller or touching the heater until the unit has been switched off for at least 45 minutes.

A. REMOVE THE CONTROLLER. Disconnect the Power Cord and Probes from the side of the Incubator.

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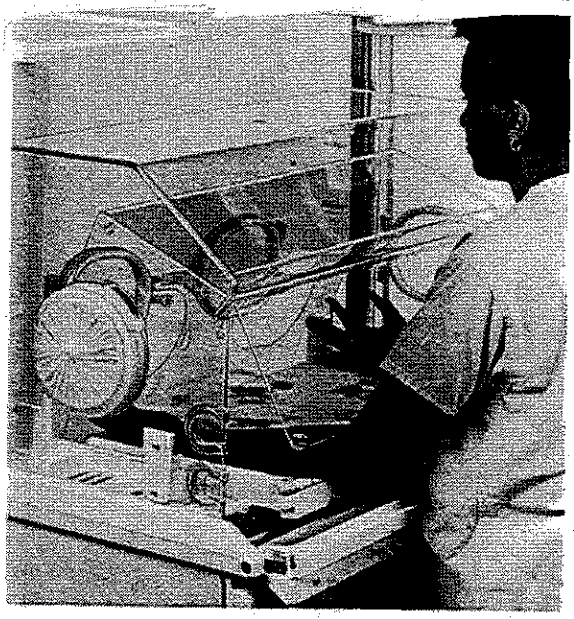
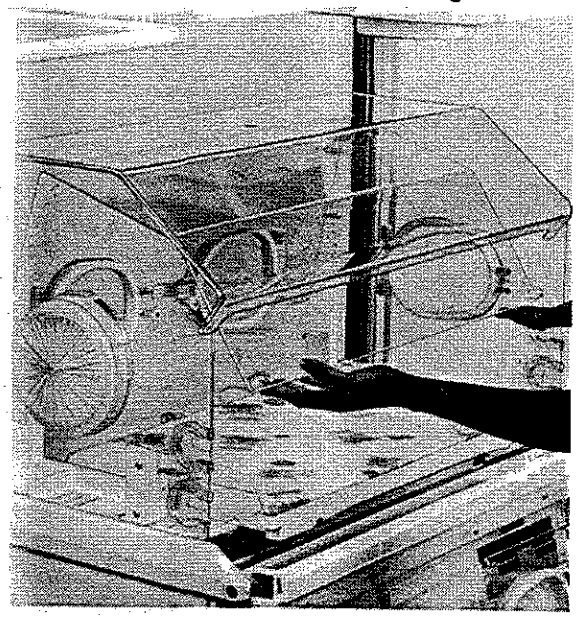
NOTE: *Refer to Figure 4.1 and slide the left–hand front panel to the left. Release the latch on each side of the Controller, then withdraw the unit from the Incubator.*

FIGURE 4.1 REMOVAL OF CONTROLLER

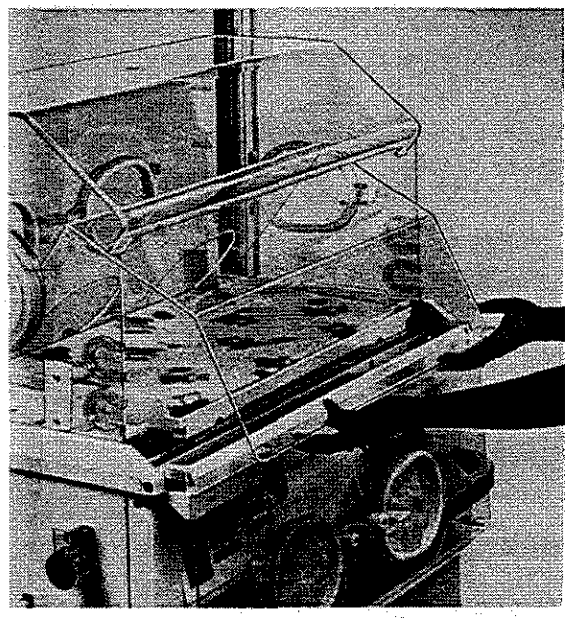
B. REMOVE THE OPTIONAL HOOD INNER WALL. Remove the Inner Wall as described in Figure 4.2.



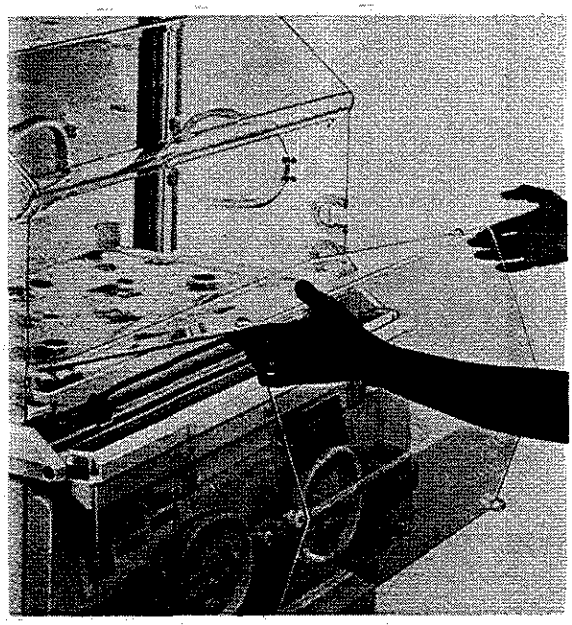
1. **RELEASE FRONT OF INNER WALL** by pushing slightly back in direction of hood slope, then down.



2. **RELEASE REAR OF INNER WALL** while resting front edge of inner wall on your arm, lift rear of inner wall, pull toward you to release, then lower.



3. **LOWER REAR OF INNER WALL AS FAR AS IT WILL GO.**



4. **REMOVE INNER WALL** by lowering in direction shown.

FIGURE 4.2 REMOVAL OF OPTIONAL INNER WALL

C. REMOVE ACCESS PANEL OPTIONAL INNER WALL. Refer to Figure 4.3. With the Access Panel completely open, remove the Inner Wall by simultaneously pulling out at the top and pushing in the downward direction.

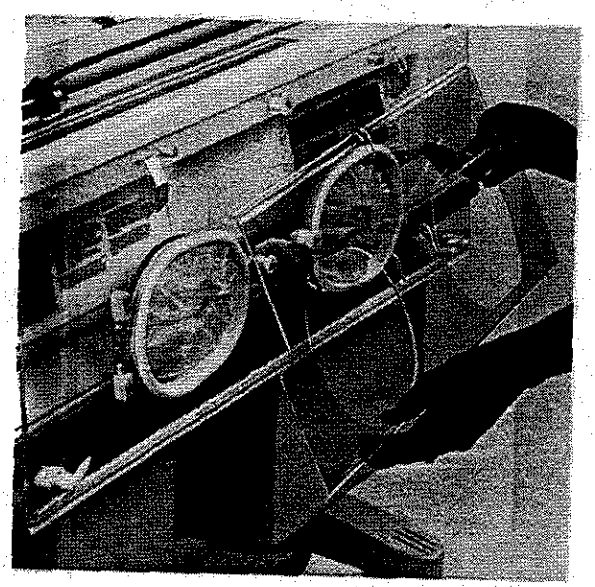


FIGURE 4.3 ACCESS PANEL OPTIONAL INNER WALL REMOVAL

D. REMOVE MATTRESS TRAY AND AIR CURTAIN COVER. Close the Access Panel and latch the Hood Assembly in the open position, then lift out the Mattress Tray. Remove and discard the disposable mattress cover.

Lift the front of the Air Curtain Cover, swing it toward the back of the Incubator past the vertical position until you feel it snap free, then slide it slightly forward to remove.

E. REMOVE THE RIGHT AND LEFT MATTRESS LIFTING BELLOWS (PNEUMATIC TILT MODELS). Refer to Figure 4.4 and remove the bellows tube from the fitting by **depressing the red collar,** then remove the tube. Remove the bellows from the Incubator.

OR

REMOVE THE MATTRESS TILT MECHANISMS (MANUAL TILT MODELS) by first loosening the two captive screws that secure them to the Main Deck.

F. REFER TO SECTION 2, PARAGRAPH 2.2.2, STEP B, and raise and then lock the Hood in place.

CAUTION: Before lifting Incubator Hood for cleaning, ensure that all mounted accessories on the Optional Rail System have been removed to prevent possible interference with the raised Hood.

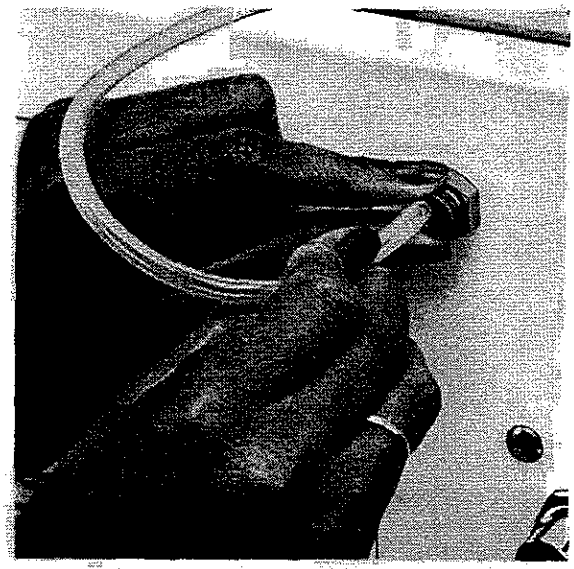


FIGURE 4.4 REMOVAL OF BELLOWS TUBE FROM COLLAR

G. **REMOVE MAIN DECK.** Rotate the Main Deck Retainer (Figure 4.5) parallel with the slot, then lift out the Main Deck and Hood Seat Gasket.

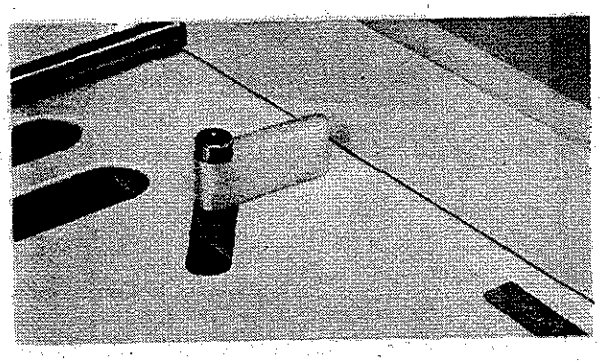


FIGURE 4.5 REMOVAL OF MAIN DECK

H. **REMOVE AIR INTAKE TUBE.** Grasp the Air Intake Tube (Figure 4.6), twist and pull it toward the front of the Incubator until the end of the tube clears the gasket. Remove the tube from the base assembly.

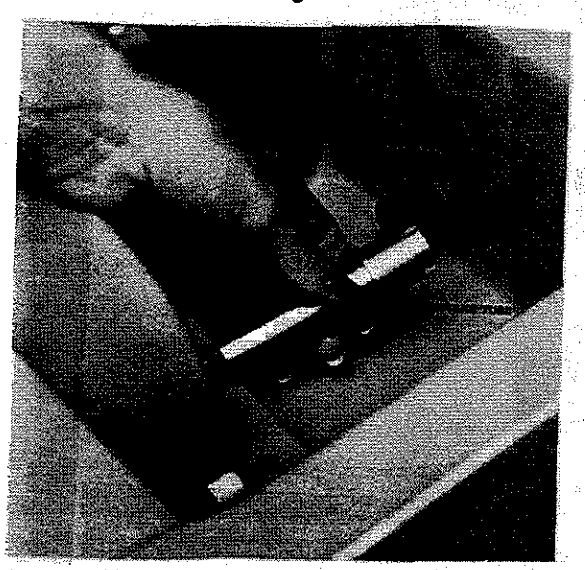


FIGURE 4.6 REMOVAL OF AIR INTAKE TUBE

I. **REMOVE DISPOSABLE ACCESS DOOR CUFF** from each Access Door Gasket by pulling it off from the outside; discard the cuffs.

J. **REMOVE ACCESS DOOR GASKETS** from each side of the hood by pulling them free.

K. **REMOVE TUBING ACCESS GROMMETS** from each side of the Hood by pulling them free.

L. **REMOVE DISPOSABLE IRIS ENTRY PORT SLEEVES** by pulling each Sleeve off the retainer rings; discard the sleeves.

M. **REMOVE THE AIR INTAKE MICROFILTER COVER** by loosening the two thumbscrews.

4.2.2 CLEANING

CLEANING AGENTS

An intermediate-level detergent/disinfectant registered by the U.S. Environmental Protection Agency should be used, but only after the incubator is empty and disassembled as described in Paragraph 4.2.1. When using any cleaning agent, follow the manufacturer's directions for use. After removing all solid wastes and contaminants from the disassembled parts, clean them as follows:

SKIN TEMPERATURE PROBE

Use a detergent/disinfectant to thoroughly clean all surfaces, then dry with a clean cloth or paper towel.

HUMIDITY CHAMBER AND FILL PIPE, AIR INTAKE TUBE, ACCESS DOOR GASKETS, TUBING ACCESS PORTS, AND MAIN DECK GASKET

Fill the humidity chamber with a detergent/disinfectant, then remove the W-shaped baffle from the chamber and dry it with a clean cloth or paper towel. Place the Air Intake Tube, Access Door Gaskets, Tubing Access Ports, and Main Deck Gasket into the solution.

NOTE: *If necessary, a larger container may be used, but if the chamber is not used, then the Fill Pipe and Humidity Chamber must be cleaned separately.*

Allow parts to soak as recommended by the manufacturer, then remove them and dry completely with a clean cloth or paper towel. Drain the Humidity Chamber, scrub it thoroughly, including all indentations, then dry the chamber and Fill Pipe (inside and out) with a clean cloth or paper towel.

If it is necessary to remove the fill pipe for cleaning, rotate the Fill Pipe Assembly about 1/4 turn to the left. Loosen the thumbscrew that secures the Fill Pipe Bracket and rotate the bracket 1/4 turn to the left. Unscrew the Fill Pipe Assembly by rotating it counterclockwise as shown in Figure 4.7. Clean the Fill Pipe Assembly and the sleeve that becomes a loose part when the Fill Pipe Assembly is unscrewed.

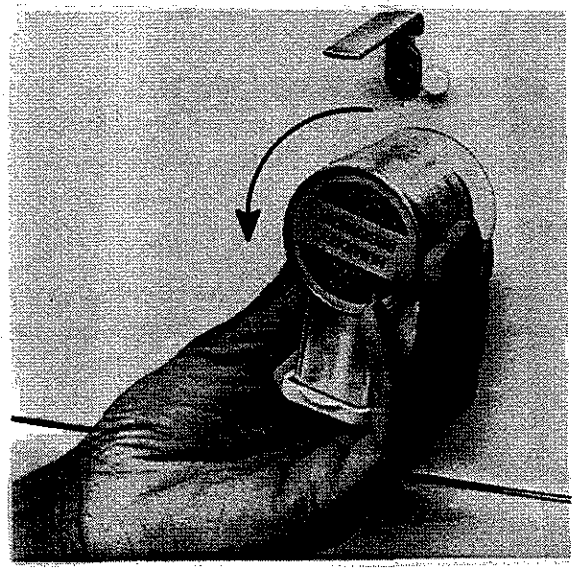


FIGURE 4.7 REMOVAL OF HUMIDITY FILL PIPE ASSEMBLY

CONTROLLER

The portions of the Controller external to the controlled Incubator environment include the front panel and the top, bottom, and two sides of the chassis. Wipe these portions clean with a cloth dampened with a detergent/disinfectant.

CAUTION: Some chemical cleaning agents may be conductive and/or leave a residue which may permit a build-up of dust or dirt which may be conductive. Do not permit cleaning agents to contact electrical components. Do not spray cleaning solutions onto any of these surfaces.

The portions of the Controller that are within the controlled environment are on the rear surface. Included are the air temperature probe, the fan impeller, the heater, the gaskets, and the surface of the Controller to which these components are mounted.

CAUTION: Failure to clean could result in sufficient lint build-up to reduce airflow, which will affect temperature control and cause high oxygen concentrations.

1. Remove any lint build-up; pay particular attention to the fan impeller, heater, air temperature probe, and air flow sensor.
2. Clean these surfaces with a detergent/disinfectant, then dry with a clean cloth or paper towel.

NOTE: *A disinfecting tank is available as an accessory from Hill-Rom Air-Shields to facilitate cleaning the rear surface of the Controller. Immerse the Controller rear surface into the tank after filling it with a detergent/disinfectant, then allow it to soak as recommended by the manufacturer.*

MATTRESS TRAY, AIR CURTAIN COVER AND MAIN DECK

Use a detergent/disinfectant to clean all surfaces thoroughly, then dry with a clean cloth or a paper towel.

BELLOWS (PNEUMATIC TILT MODELS)

Remove all solid wastes and contaminants from the Bellows. When using any cleaning agent, follow the manufacturer's directions for use. If contaminants or cleaning agents enter the Bellows, it is recommended to discard the Bellows rather than disinfect and aerate the Bellows' interior.

MATTRESS TILT CONTROLS (MANUAL TILT MODELS)

Remove all solid wastes and contaminants from the Mattress Tilt Control. An intermediate-level detergent/disinfectant registered by the U.S. Environmental Protection Agency should be used to clean the mechanical mechanism. When using any cleaning agent, follow the manufacturer's directions for use.

HOOD AND CABINET STAND

Use a detergent/disinfectant to clean all surfaces of the hood thoroughly, including the inner wall and access door heat shield. Make sure to clean all holes, indentations, baffles, etc., then dry with a clean cloth or paper towel.

CAUTION:

- **Alcohol can cause crazing of the clear Acrylic Hood. Do not use alcohol for cleaning.**
- **Do not expose the hood assembly to direct radiation from germicidal lamps. Ultraviolet radiation from these sources can cause cracking of gaskets, fading of paint, and crazing of the clear Acrylic Hood.**

AIR INTAKE MICROFILTER

Do not attempt to clean or reverse the microfilter. Replace it if it is visibly dirty or older than 3 months. Before installing a new filter, clean the Microfilter chamber and cover with a detergent/disinfectant.

WARNING: A dirty Inlet filter may affect oxygen concentration and/or cause carbon dioxide build-up. Be sure the filter is checked on a routine basis commensurate with local conditions. Particularly, if the Incubator is used in an unusually dusty environment, more frequent replacements may be necessary.

4.2.3 REASSEMBLY AFTER CLEANING

NOTE: *Inspect all cleaned components for any breakage or cracks before reassembling into the Incubator. Harsh cleaning agents may attack some of the plastics used in the Patient Compartment.*

A. **INSTALL THE AIR INTAKE TUBE** (into the Base Assembly) by reversing the procedure shown in Figure 4.6.

B. **INSTALL THE MAIN DECK AND HOOD SEAT GASKET** into the Base Assembly as shown in Figure 4.8. Rotate the Main Deck Retainer (Figure 4.5) to secure the deck.